Evaluation Report of NIH K-12 Program

Title: Evaluation Report for the NIH4 Module, *Using Technology to Study Cellular and Molecular Biology*

Date: 2002

Description:
This report evaluates one component within the NIH K-12 program, the NIH Curriculum Supplements. The NIH Curriculum Supplements are K-12 teacher's guides to two weeks' of lessons that explore the science behind current health topics. The modules are sent free of charge upon request to educators across the United States. Over 50,000 educators have one or more curriculum supplement.

This study specifically examines the results of the field tests conducted during the development of:

Using Technology to Study Cellular and Molecular Biology   (Grades 9 – 12)

This study was designed to determine the effectiveness of the module as a supplementary addition in the K-12 science curriculum. The field test sites were selected from volunteers who were chosen to maximize inclusion of various races, ethnicities, and geographic regions. The evaluation consisted of a field test with close-to-complete instructional materials. The surveys measured student knowledge using a pre/post test. The teachers also commented on the effectiveness of the lessons and their implementation. These resulted were used to identify strengths that were highlighted and weaknesses that were corrected in the final draft. The teachers' comments were included in the final draft as "tips from teachers" on specific lessons.

Evaluation Report
for the
NIH4 Module:
Using Technology to Study Cellular & Molecular Biology

BSCS Evaluation Report ER 2002-01 April

Theodore A. Lamb
Research & Evaluation Division
Biological Science Curriculum Studies
5415 Mark Dabling Blvd.
Colorado Springs, CO 80918-3842
719.531.5550

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BSCS

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Section I. Executive Summary

BSCS developed a learning module on "Using Technology to Study Cellular and Molecular Biology" funded by a grant from the National Institutes of Health. This module was one of three funded by the grant. The evaluation study was designed to determine its effectiveness as supplementary material for high school biology instructional materials in trials in high school classes. The sites were selected from volunteers who were selected to maximize inclusion of different races, ethnicities, geographic regions, and urban-suburban-rural schools.

There were eight primary and five secondary schools in the study. The primary school teachers received a field test orientation at BSCS and were paid to be in the study. The secondary school teachers received no orientation or funding but were interested in participating and thus were included. The classes ranged from standard biology classes to honors biology classes. There were 569 students and 13 teachers in the study.

The Formative Evaluation consisted of a pilot test with draft materials and a field test with close-to-complete materials. Students and teachers completed evaluation questionnaires after using the materials in March, 2002. The data were entered into a database and analyzed with SPSS. Tables 49-53 on pages 36-39 are brief "Formative Evaluation Snapshots" of each lesson and are good starting points for developers. The comments on Lessons 1-4, in their totality, are included in Appendix I for the students and Appendix J for the teachers. These appendices also include comments to Most and Least Valuable Aspects of the Module and Suggestions for Changes. The developers are urged to review the comments to sample their diversity, large number, and identify possible areas for change.

The Summative Evaluation consisted of pretest and posttest results from administration of Student Knowledge Surveys. Before using the materials the students took a Knowledge Survey and then the same survey again after completing the materials.   The t-test and one-way analysis of variance results suggest statistically significant differences in the increases from pretest to posttest scores. In addition, the teachers responded to questions about the success of the materials in achieving the learning outcomes.   These results indicated high agreement with statements on the effectiveness of the module in achieving the established learning outcomes for each lesson. A response category of "Not Sure" which was available to students to indicate total lack of knowledge and blatant uncertainty was also examined and yielded a significant reduction in frequency from pretest to posttest knowledge surveys.

The final sections briefly discuss the results and recommendations for the developers. Recommendations include:
- paying the secondary site teachers a nominal honorarium to return materials in a timely fashion,
- adding more time in future proposals for evaluation data entry, analysis and report writing,
- a local pilot test, and
- tailoring future proposals to include modifications to enable access by persons with disabilities.

Section II. Background Information Concerning the Program

A.   Background and Goals of the Program

"Using Technology to Study Cellular and Molecular Biology" is one of three modules created with funding from a grant from the National Center for Research Resources (NCRR) which is part of the National Institutes of Health (NIH).

The final product will be an instructional module composed of four lessons which are designed to be taught in sequence for approximately a week. It is intended to be a replacement for a part of a standard curriculum in high school biology. The module is designed to help students achieve the following goals associated with scientific literacy:

- understand a set of basic scientific principles related to the nature and role of technology in biological science and the effects of technology on human health;
- experience the process of scientific inquiry and develop an enhanced understanding of the nature and methods of science, and;
- recognize the role of science in society and the relationship between basic science and human health.

B.   The Curriculum Development Process.

BSCS uses a curriculum development process that involves an advisory board, an external design team, and an internal writing team. In the Initial Phase, an Advisory Board meeting of experts in the field is convened at the beginning of the development process to identify the key or critical areas of study in the field as well as the key concepts to be conveyed in the materials. Resources are also sought from the Advisory Board.   Next, in the Content Review Phase, an external design team of subject matter experts and teachers at the appropriate grade level is brought together for several days of brainstorming and writing. This team, with the input of the Advisory Board, defines the activities and addresses options for structuring the materials. Some writing may be done but that is not the major objective. The Materials Development Phase is next. After input is gained from the Advisory Board and the external Design Team, the BSCS curriculum developers begin the serious task of putting structure and form to the materials and various activities. We then have a Field Test Phase in which the materials are tested with a national sample. The Evaluation Phase consists of analyzing and reporting the results of the Field Test. This is followed by the Final Production Phase in which the materials are modified with the suggestions from the Evaluation and the final curriculum materials are produced.

In order to facilitate the work of the Advisory Board and the external Design Team we developed and administered an Advisory Board Evaluation Form (Appendix A) and a Design Conference Evaluation form (Appendix B). No analysis was performed on the responses generated with these forms. They simply provided input to the project director about how well the meetings went and what modifications to consider for future meetings.

C.. The Instructional Materials in the Module

The final product is suitable for use with any full-year high school biology program. There are four lessons:

1. What is Technology?
2. Resolving Issues
3. Putting Technology to Work, and
4. Technology: How Much is Enough?

Each lesson contains readings and activities. There is a website for resources and activities. Additionally, there are Teacher Support Materials to increase the ability of the teachers to use the materials effectively in the classroom.

The materials are designed to incorporate an inquiry-based approach, the 5E model: Engage, Explore, Explain, Elaborate, and Evaluate.

D. Teachers, Students, and Test Sites

Primary Field Test Teachers. Field test teachers were recruited by several methods, including an advertisement placed at the BSCS website, letters of invitation to teachers who had participated in previous BSCS field tests, a notice in the BSCS newsletter, and an ad in The American Biology Teacher published by the National Association of Biology Teachers (NABT). We asked interested teachers to complete a teacher background survey to determine their level of interest and commitment and whether they would be teaching appropriate biology classes during the test period. The background surveys were reviewed by the project director and staff biologist, selected the participants, and then contacted the teachers to see if they still wanted to participate in the study. One essential criterion was whether or not the teacher had the necessary computer resources available. Additionally, even though by using volunteers we would never have a truly representative sample of schools or school districts, the staff made a concerted attempt to assure inclusion in the selection process by selecting schools that had diverse student populations and represented a variety of economic and geographic contexts.

In January, 2002, the eight selected teachers were brought to BSCS for a 2-day Field Test Orientation. During the orientation the staff introduced the teachers to the key features of the science content and specific activities of the module. The project supported all travel expenses and the participants received an honorarium of $300.00. After they used the module and BSCS had received the evaluation materials they received an additional honorarium of $400.00.

Secondary Field Test Teachers. There were more teachers who wanted to be in the field test than we had resources to accommodate. In these cases we sent the materials to the teachers and asked that they use them according to the guidelines in the Teacher Background Materials. These teachers did not receive honoraria and did not participate in a field test orientation, however. We thought this was an additional useful test of the materials which perhaps more accurately portrayed how they would be used by most teachers.

Students in the Field Test. The students at the primary test sites ranged from 9th to 10th graders in high school. There were 8 primary test schools in the study from school districts in North Dakota, California, Maryland, Texas, Hawaii, Mississippi, Colorado, and Washington, D.C. The classes included regular biology classes, Advanced Placement (AP), and Honors classes. Figure 1 depicts the dispersed locations of the primary field test sites nationally.

Tables 1 and 2 depict the demographic information for the schools in the field test with approximate breakdowns of race/ethnicity using U.S. Census Bureau categories. These data come from the responses given by the students.

Table 1. Population Characteristics of Primary Schools in the Field Test

School	% Asian	% Afr Am	% Am Ind	% White	% Nat Hw	% other (Hisp)	% 2 or more
Carrington HS	0	0	0	98	0	2	0
Pine Creek HS	0	0	2.4	92.7	0	0	4.9
Lafayette HS	3.7	18.5	0	74.1	0	0	3.7
Jay Science Academy	0	12.1	0	24.2	0	51.5	12.1
King Kekaulike HS	29.1	0	0	34.5	7.3	5.5	23.6
Monte Vista HS	40.5	0	2.4	48.8	0	2.4	4.9
Eastern HS	0	97	0	0	0	0	3
Northwest HS	6.3	25	0	37.5	1.6	18.8	10.9

Table 2. Another depiction of the Population Characteristics of the Primary Field Test Sites
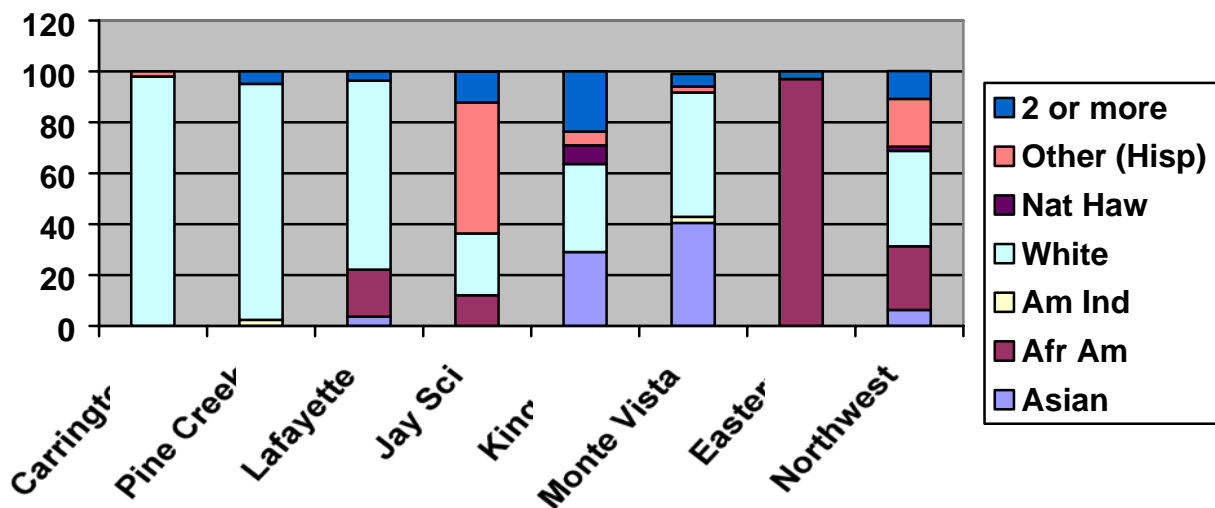
Figure 1: Primary Field Test Sites for
Using Technology to Study Cellular & Molecular Biology

Carrington HS
Carrington, ND
Rural, low diversity
Majority = white

Monte Vista HS
Danville, CA
Suburban, high diversity
Majority = Asian & white

Northwest HS
Germantown, MD
Urb/Sub, high diversity
Majority = Hispanic & white

Eastern Senior HS
Washington, DC
Urban, low diversity
Majority = African American

King KeKaulike HS
Pukalani, HI
Suburban, high diversity
Majority = Asian & white

Pine Creek HS
Colorado Springs, CO
Suburban, low diversity
Majority = white

Lafayette County HS
Oxford, MS
Rural, medium diversity
Majority = white

Jay Science Academy
San Antonio, TX
Urban, high diversity
Majority = Hispanic

Table 3. Population Characteristics of Secondary Schools in the Field Test

School	% Asian	% Afr Am	% Am Ind	% White	% Nat Hw	% other (Hisp)	% 2 or more
Cornell HS	0	0	0	100	0	2	0
Mt. Michael School	2.6	2.6	0	84.2	0	5.3	5.3
Sallisaw HS	0	0	51.6	41.9	0	0	6.5
Catholic Central HS	22.2	0	0	50.0	5.6	11.1	11.1
Joliet Central HS	0	24.5	0	50.0	0	13.3	12.2

Table 4. Another depiction of the Population Characteristics of the Primary Field Test Sites

Figure 2: Primary & Secondary Field Test Sites for
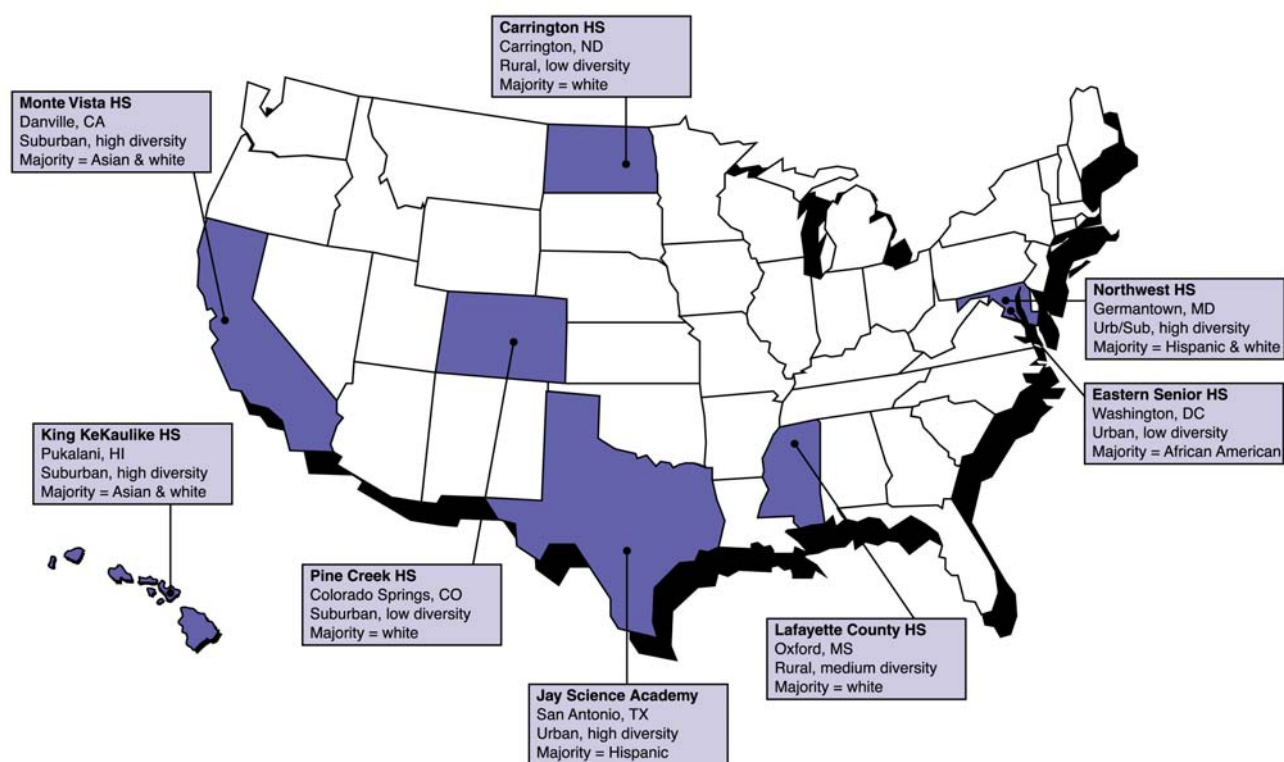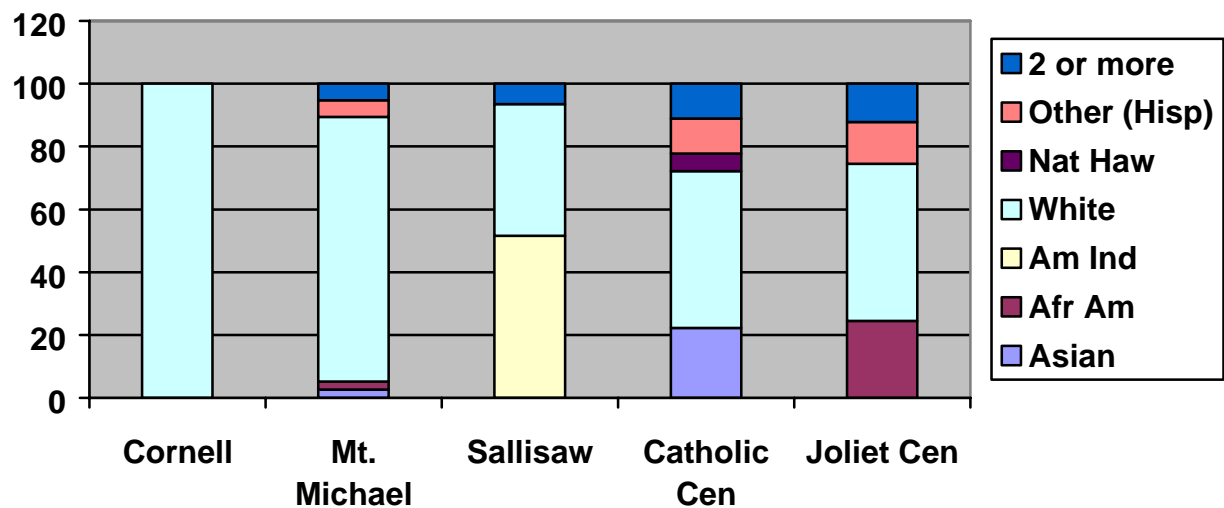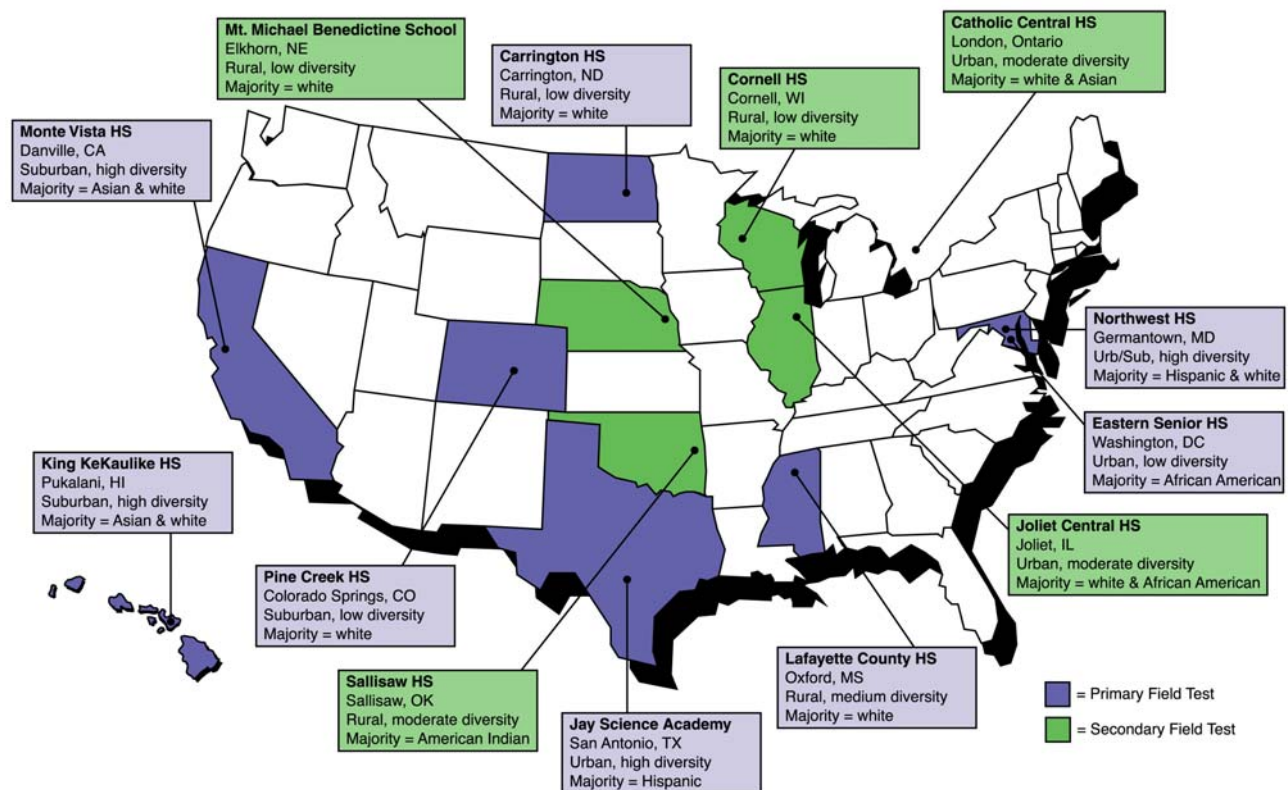Using Technology to Study Cellular & Molecular Biology

Section III. Description of the Evaluation Study

A.   Purposes of the Evaluation

The evaluation had two primary purposes. The first is to gather formative evaluation data about the functionality and usability of the materials. The curriculum developers use formative evaluation findings to revise and improve the final version of the module. The second is to gather preliminary summative information about the module's effectiveness in achieving the learning outcomes.

B.   Evaluation Design

Formative Evaluation Design. The formative evaluation includes insights gleaned from the pilot test with local teachers as well as the national field test. There are two primary sources of data for formative data: the Teacher Evaluation of the Materials Survey (TEMS) and the Student Evaluation of the Materials Survey (SEMS). Appendix C contains the instructions we gave to the teachers to facilitate their administration of the surveys. Appendices D and E contain copies of the TEMS and SEMS respectively. The TEMS contains a series of questions on the following topics for each lesson in the module:

- Text-based Content
- Graphic Content of the Text-based Material
- Format of the Text-based Material
- Organization of the Text-based Material
- Instructional Design of the Text-based Material
- Relevance of the Text-based Material
- the Website.

The teachers to respond to questions about each of these topics on a scale of Strongly Agree to Strongly Disagree and have space to make comments or elaborate their ratings.

At the end of the TEMS we ask questions about the overall difficulty of the module, what the three most valuable aspects and three least valuable aspects were of the module. We also ask the teachers to make specific suggestions to the curriculum developers to improve the module.

The SEMS has a reduced number of topics and items to which the students respond. Similar to the TEMS, we ask the students to respond to items on the following topics for each lesson in the module:

- Text-based Materials,
- Graphic Content of the Text-base Materials, and
- the Website.

The students also have opportunities to make comments about the module and activities, rate the difficulty of the module, identify the main strengths and weaknesses of the module, and make specific suggestions to the developers.

Summative Evaluation Design. Student Data. The summative evaluation focuses on how effectively the materials helped the students achieve the learning outcomes for each lesson. The present study uses the "One-Group Pretest-Posttest Design" articulated by Campbell and Stanley (1963).

Campbell and Stanley represent the design as:

$$O_1 \longrightarrow X \longrightarrow O_2$$
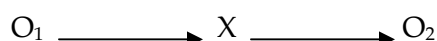
The initial Observation (O_1) is the pretest, which is followed by administration of the experimental treatment (X) and then the second Observation (O_2) or posttest.

Our initial observation (O_1) is the Student Knowledge Survey 1 (SKS1) a pretest of student knowledge on using technology for cellular and molecular biology which teachers gave their students before any exposure to the materials. Teachers then taught the module in their classes until completed. This essentially is the classic experimental treatment (or X in Campbell and Stanley's diagram).   The second observation (O_2) is a posttest composed of the same items as the pretest. These items are contained in our Student Knowledge Survey 2. Teachers administered the survey to students at the end of the field test. Appendices E and F contains copies of these surveys. The students answered True or False to statements from which we determined their pretest and posttest scores. In addition, they were given the option, in both the pretest and posttest of answering "Not Sure" on the items in order to estimate the level of sureness they had with their answers.

This type of summative evaluation is often termed "ipsative", that is, the norm or comparison against which the student is measured is their own prior performance (a pretest). The present performance (a posttest) is compared to the prior performance. In essence, the posttest is the student's "personal best" although it may not be the best in the class. This type of assessment is useful because of the different of levels of knowledge or ability at which students enter a class (or use an instructional module). The "difference" or "gain" scores show how much they have increased. A student at the top end on the pretest may not increase as much as the student who scores lower on the pretest merely because there is less room to improve.

Summative Evaluation. Teacher Data. The summative evaluation also contains a second source of data. The teachers use the TEMS to make judgments on how effectively the materials achieved each lessons learning outcomes. Achieving these learning outcomes is the ultimate goal of each lesson. Their answers provide an additional source of summative evaluation data.

Section IV. Results

A.   Surveys Returned.   The module was tested in 13 schools. We received a total of 569 complete student survey sets. There were 345 complete sets from the primary sites and 224 complete sets from secondary field test sites. A student survey set consists of a SEMs, an SKS1, and

an SKS2. There were 9 SEMs, 12 SKS1s, and 9 SKS2s which did not have all of the accompanying survey forms to complete a survey set. This was probably due to student sickness or absence from class for other reasons. We needed all three for complete analysis of the student data. Each teacher completed a Teacher Evaluation of the Materials Survey as well for a total of 13 (8 primary and 5 secondary).

B. Demographic Results from Surveys Returned. The student surveys yielded the following results:

The study population was:

Female	52.5 %
Male	47.5 %

Of the valid responses to the question on "Race/Ethnicity" there were:

African American	14.5%
American Indian or Aleut	3.2%
Asian	7.6%
White	56.1%
Native Hawaiian/Pac Isl	1.1%
Hispanic	9.0%
Mixed Race	8.5%

Grade Level Distribution	
6 =	.2%
9 =	35.9%
10 =	52.4%
11 =	6.9%
12 =	4.6%

C.   Results of Formative Evaluation

The formative evaluation results come from questionnaires completed by the teachers and the students. Appendices D and G contain copies of the questionnaire for each group. The questionnaires were completed after the they had completed using the materials or while they were using the materials. There are demographic questions, fixed-response questions, and open-ended questions on both questionnaires.

The students responded to three sets of questions for each lesson. There were questions on the:

- Text-based Materials,
- Graphic Content of the Text-based Materials, and the
- Website.

The students indicated their level of agreement or disagreement from strongly agree to strongly disagree with statements in each section. The Tables in the following section provide the results in

terms of the percentage of students who indicated which response. In addition, the items are assigned a value: Strongly Disagree = 1, Disagree = 2, Disagree a Little = 3, Agree a Little = 4, Agree = 5, and Strongly Agree = 6. With these values means and standard deviations were calculated and also are reported.

In addition, the students were able and encouraged to make comments on any question in the survey on all lessons. Those comments, in their totality, for all lessons are included in Appendix I.

The students were also asked to estimate the overall level of difficulty of the module, identify the main strengths and weaknesses of the module, and make specific suggestions for the developers to improve the module.

Lesson 1 Formative Evaluation from Students. The results for Lesson 1 are presented in three tables: one for the Text-Based Materials items, one for the Graphics Content items, and one for the Website items.

Table 5. Lesson 1 Text-based Materials Questions Percentage Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The lesson was interesting.	1.8	4.7	7.6	32.9	44.1	9.0	4.40	1.03
2. I could understand the examples and explanations.	.2	2.2	5.8	20.5	54.2	17.1	4.78	.88
3. The lesson made me think about new things and questions.	1.4	8.0	9.0	25.9	37.4	18.1	4.61	.20
4. I could read the material easily.	.7	1.3	6.4	23.8	49.6	18.2	4.75	.92
5. I understood the scientific information clearly.	1.8	4.0	10.4	29.3	42.5	12.0	4.43	1.07
6. The materials and concepts were related to real life examples.	1.1	2.9	5.7	18.8	46.9	24.6	4.81	1.03
7. The materials and concepts fit nicely with the other materials in this course.	2.0	3.1	7.2	28.7	45.7	13.3	4.53	1.05

Table 6. Lesson 1 Graphic Content of the Text-based Materials Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The graphic content helped me understand the material covered.	1.5	5.2	7.5	24.3	46.4	15.1	4.54	1.09
2. The illustrations promoted discussion	1.7	3.8	11.0	26.5	44.8	12.2	4.45	1.07
3. The illustrations promoted thinking and questioning.	1.9	3.4	8.0	28.2	45.0	13.5	4.51	1.06
4. The illustrations motivated me to read the text.	7.4	13.9	17.2	30.3	24.3	6.8	3.71	1.35

Lesson 1 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. The lesson 1 difficulty mean = 4.47, std. dev. = 1.86.

Lesson 2 Formative Evaluation from Students. The results for Lesson 2 are presented in three tables: one for the Text-Based Materials items, one for the Graphics Content items, and one for the Website items.

Table 7. Lesson 2 Text-based Materials Questions Percentage Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The lesson was interesting.	2.8	4.3	7.6	21.2	42.0	22.1	4.62	1.19
2. I could understand the examples and explanations.	.4	3.4	7.1	22.0	49.0	18.2	4.71	.98
3. The lesson made me think about new things and questions.	3.7	7.1	14.7	27.6	34.6	12.3	4.19	1.23
4. I could read the material easily.	.8	2.7	7.5	21.9	45.5	21.7	4.74	1.02
5. I understood the scientific information clearly.	1.1	3.4	8.5	26.7	46.0	14.2	4.56	1.02
6. The materials and concepts were related to real life examples.	2.5	5.5	8.5	30.3	40.2	13.1	4.39	1.14
7. The materials and concepts fit nicely with the other materials in this course.	1.7	2.8	7.0	23.6	46.9	18.0	4.49	1.01

Table 8. Lesson 2 Graphic Content of the Text-based Materials Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The graphic content helped me understand the material covered.	1.7	2.8	7.0	23.6	46.9	18.0	4.65	1.05
2. The illustrations promoted discussion	1.5	5.5	8.1	24.6	43.9	16.4	4.53	1.12
3. The illustrations promoted thinking and questioning.	1.7	4.2	9.7	28.2	37.3	18.9	4.52	1.05
4. The illustrations motivated me to read the text.	5.3	9.7	18.7	25.1	31.6	9.6	3.97	1.32

Table 9. Lesson 2 Website Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The website was clearly connected to the lesson.	2.6	2.8	5.7	18.3	41.2	29.4	4.81	1.32
2. I was able to navigate easily in the website without confusion.	2.5	4.3	9.5	20.0	38.4	25.4	4.64	1.23
3. The website made the lesson more understandable.	2.6.	3.7	7.8	19.3	39.2	27.4	4.71	1.21
4. The website made the lesson more interesting.	3.3	4.5	7.3	18.4	34.6	31.8	4.71	1.30

Lesson 2 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. The lesson 2 difficulty mean = 4.14, std. dev. = 2.01.

Lesson 3 Formative Evaluation from Students. The results for Lesson 3 are presented in three tables: one for the Text-Based Materials items, one for the Graphics Content items, and one for the Website items.

Table 10. Lesson 3 Text-based Materials Questions Percentage Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The lesson was interesting.	3.6	5.7	8.8	20.7	42.1	19.1	4.49	1.26
2. I could understand the examples and explanations.	3.1	6.1	10.7	25.5	42.0	12.6	4.35	1.20
3. The lesson made me think about new things and questions.	3.4	7.1	11.9	22.9	38.8	15.9	4.34	1.27
4. I could read the material easily.	3.3	4.0	9.4	26.1	41.5	15.7	4.46	1.18
5. I understood the scientific information clearly.	3.4	7.7	10.7	26.4	38.3	13.4	4.29	1.25
6. The materials and concepts were related to real life examples.	2.5	5.0	6.7	20.0	40.9	25.0	4.67	1.21
7. The materials and concepts fit nicely with the other materials in this course.	3.1	2.1	10.9	22.5	44.5	16.9	4.54	1.14

Table 11. Lesson 3 Graphic Content of the Text-based Materials Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The graphic content helped me understand the material covered.	2.2	5.5	8.1	22.6	40.7	21.0	4.57	1.19
2. The illustrations promoted discussion	2.8	5.3	10.3	26.2	37.1	18.3	4.57	1.21
3. The illustrations promoted thinking and questioning.	2.4	5.9	8.8	21.8	42.5	18.6	4.52	1.20
4. The illustrations motivated me to read the text.	6.1	8.3	15.8	23.9	33.4	125	4.08	1.37

Table 12. Lesson 3 Website Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The website was clearly connected to the lesson.	1.8	2.7	5.9	14.3	36.6	38.6	4.97	1.14
2. I was able to navigate easily in the website without confusion.	3.7	5.1	9.2	22.1	34.5	25.5	4.55	1.30
3. The website made the lesson more understandable.	3.0	5.2	6.8	18.2	36.6	30.2	4.71	1.27
4. The website made the lesson more interesting.	3.9	5.7	4.6	15.5	31.4	39.0	4.82	1.35

Lesson 3 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. The lesson 3 difficulty mean = 5.05, std. dev. = 2.00.

Lesson 4 Formative Evaluation from Students. The results for Lesson 4 are presented in three tables: one for the Text-Based Materials items, one for the Graphics Content items, and one for the Website items.

Table 13. Lesson 4 Text-based Materials Questions Percentage Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The lesson was interesting.	4.5	6.2	10.2	25.0	43.1	10.9	4.29	1.25
2. I could understand the examples and explanations.	1.5	4.1	8.9	23.0	49.7	12.8	4.54	1.05
3. The lesson made me think about new things and questions.	3.4	7.7	11.3	24.2	39.3	14.1	4.31	1.26
4. I could read the material easily.	1.2	4.5	8.4	22.4	47.1	16.5	4.59	1.07
5. I understood the scientific information clearly.	3.4	4.3	9.6	24.9	45.8	13.7	4.50	1.09
6. The materials and concepts were related to real life examples.	2.4	5.3	8.1	23.2	42.7	18.3	4.53	1.18
7. The materials and concepts fit nicely with the other materials in this course.	2.5	4.4	9.1	24.5	47.6	12.0	4.46	1.11

Table 14. Lesson 4 Graphic Content of the Text-based Materials Questions Results for Students.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The graphic content helped me understand the material covered.	3.0	5.5	9.6	29.1	40.7	12.2	4.35	1.17
2. The illustrations promoted discussion	3.5	6.0	13.3	25.5	38.8	12.9	4.29	1.23
3. The illustrations promoted thinking and questioning.	3.5	6.1	15.7	24.7	35.8	14.1	4.26	1.26
4. The illustrations motivated me to read the text.	6.4	9.7	17.9	23.7	31.8	105	3.96	1.37

Lesson 4 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. The lesson 4 difficulty mean = 4.34, std. dev. = 2.15.

Additional Analyses.

    C. Students Interest in Science. The students were also asked three questions to determine their interest in science. The results for these three questions are summarized in Table 15.

Table 15. Students' Level of interest in Science Questions Results.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. I am very interested in science, in general.	3.2	7.6	8.5	35.9	31.2	13.7	4.26	1.21
2. I am very interested in Biology.	5.1	7.9	14.4	38.4	24.1	10.0	3.99	1.25
3. I am good at science, in general.	2.5	7.6	12.5	40.7	31.0	5.8	4.08	1.09

Overall Module Results.

    Module Difficulty. The students were also asked about the overall difficulty of the module. They rated the difficulty on a scale of 1 to 9 in which 1=too easy, 5=just right, and 9=too hard. The average level of difficulty was 4.89, std. dev. = 1.76.

    Most and Least Valuable Aspects of the Module and Suggestions for Improvements. The students were asked to respond to an open-ended question on the most and least valuable aspects of the module and suggestions for improvements in the module. These comments, in their totality, are included in Appendix I.

    Lesson Comparisons from Students. The lessons each have scores from the students on several dimensions.   Table 16 depicts the average scores and std. dev. for each lesson when compared to the other lessons.

Table 16. Comparison of Lessons by Evaluation Dimension: Student Results

Evaluation Dimension	Lesson 1 What is technology? Mean & Std. dev.	Lesson 2 Resolving Issues Mean & Std. dev.	Lesson 3 Putting Technology to Work Mean & Std. dev.	Lesson 4 Technology: How Much is Enough? Mean & Std. dev.
Text-based Content	4.58 .71	4.54 83	4.45 .98	4.69 .93
Graphic Content	4.29 .91	4.41 .95	4.40 1.06	4.23 1.09
Website	N/A	4.71 1.11	4.78 1.08	N/A
Level of Difficulty (Scale of 1-9)	4.47 1.86	4.14 2.01	5.05 2.00	4.34 2.15

Formative Evaluation Results from Teachers. The teachers completed a "Teacher Evaluation of the Materials Survey" or TEMS. This survey had a page of general information about their classes and how they used the materials. The TEMS had more items for the teachers to respond to such as format, organization, and instructional design of the materials as well as the overall questions on the module.

      Formative Evaluation Results for Each Lesson from the Teachers. The results for each lesson are presented in eight tables: Text-Based Materials, Graphics Content items, Format of the Text-Based Materials, Organization of the Text-based Materials, Instructional Design of the Text-based Materials, Relevance of the Text-based Materials, Website (where applicable), and Effectiveness in Achieving Learning Outcomes. This is followed by a Table comparing the teacher results for each lesson.

Table 17. Lesson 1 Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The content was accurate and current.	0	0	0	0	46.2	53.8	5.54	.52
2. The reading level was appropriate for my students.	0	0	0	0	63.6	36.4	5.36	.51
3. The vocabulary was listed separately in a useful glossary.	0	0	0	0	50	50	5.50	.55
4. The material stimulated new thinking and inquiry.	0	0	0	23.1	30.8	46.2	5.23	.83
5. The examples and explanations were at the appropriate level.	0	0	0	7.1	64.3	28.6	5.21	.58
6. The material was engaging (i.e. the students got more interested in the science content).	0	0	0	21.4	42.9	35.7	5.14	.77
7. The students could understand the scientific information clearly.	0	0	0	14.3	64.3	21.4	5.07	.62

Table 18. Lesson 1 Graphic Content of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Illustrations, charts, maps, or graphs were clear and meaningful.	0	0	14.3	0	50	35.7	5.07	.99
2. Graphic content helped students understand the material covered.	0	0	14.3	7.1	50	28.6	4.93	.99
3. Illustrations promoted student thinking, discussion, problem solving, and inquiry.	0	0	0	27.3	45.5	27.3	5.00	.76
4. Illustrations motivated students to read the text.	0	0	28.6	14.3	57.1	0	4.29	.95
5. The material was engaging (i.e. it got them to do interesting things	0	0	14.3	21.4	35.7	28.6	4.79	1.05

Table 19. Lesson 1 Format of the Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Lessons contained an appropriate amount of material.	0	0	6.7	0	53.3	40	5.27	.79
2. The size and format of print was appropriate.	0	0	14.3	0	50	35.7	5.07	.99

Table 20. Lesson 1 Organization of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The organization of the lessons (chronological, thematic) facilitated the development of specific concepts or skills identified in the lesson objectives.	0	0	0	6.7	40	53.3	5.47	.64
2. Main concepts were presented logically.	0	0	0	6.7	46.7	46.7	5.40	.63
3. The information was presented at an age-appropriate pace.	0	0	6.7	0	66.7	26.7	5.13	.74

Table 21. Lesson 1 Instructional Design of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The amount of prerequisite knowledge required to understand the material was acceptable.	0	0	7.1	14.3	57.1	21.4	4.93	.83
2. The learning objectives were stated clearly.	0	0	0	7.1	57.1	35.7	5.29	.61
3. The instruction followed an inquiry-based approach.	0	0	0	14.3	50	35.7	5.21	.69

Table 22. Lesson 1 Relevance of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Materials and concepts were related to real life examples.	0	0	0	0	66.7	33.3	5.33	.49
2. Module materials and concepts fit nicely with my existing instructional materials.	0	0	0	14.3	50	35.7	5.21	.69

Table 23. Lesson 1 Effectiveness in Achieving Learning Outcomes Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Students should be able to explain what technology is.	0	0	0	0	53.3	46.7	5.47	.49
2. Students should recognize that human intervention is the common bond among technologies.	0	0	0	6.7	53.3	40	5.33	.62
3. Students should be able to use the scale to distinguish between "large" and "small" objects..	0	0	0	14.3	42.9	42.9	5.29	.73

Lesson 1 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. As judged by teachers, the lesson 1 difficulty mean = 4.27, std. dev. = 1.87.

Table 24. Lesson 2 Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The content was accurate and current.	0	0	0	0	60.0	40.0	5.40	.51
2. The reading level was appropriate for my students.	0	0	0	0	60.0	40.0	5.40	.52
3. The vocabulary was listed separately in a useful glossary.	0	0	0	0	50	50	5.50	.54
4. The material stimulated new thinking and inquiry.	0	0	0	6.7	53.3	40.0	5.33	.62
5. The examples and explanations were at the appropriate level.	0	0	0	6.7	60.0	33.3	5.27	.59
6. The material was engaging (i.e. the students got more interested in the science content).	0	0	0	6.7	66.7	26.7	5.20	.56
7. The students could understand the scientific information clearly.	0	0	0	13.3	73.3	13.3	5.00	.54

Table 25. Lesson 2 Graphic Content of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Illustrations, charts, maps, or graphs were clear and meaningful.	0	0	6.7	0	53.8	38.5	5.23	.83
2. Graphic content helped students understand the material covered.	0	0	0	8.3	41.7	50.0	5.42	.67
3. Illustrations promoted student thinking, discussion, problem solving, and inquiry.	0	0	0	9.1	36.4	54.5	5.45	.69
4. Illustrations motivated students to read the text.	0	0	0	16.7	66.7	16.7	5.00	.63
5. The material was engaging (i.e. it got them to do interesting things	0	0	0	6.7	33.3	60.0	5.53	.64

Table 26. Lesson 2 Format of the Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Lessons contained an appropriate amount of material.	0	0	0	13.3	53.3	33.3	5.20	.68
2. The size and format of print was appropriate.	0	0	0	0	46.2	53.8	5.54	.52

Table 27. Lesson 2 Organization of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The organization of the lessons (chronological, thematic) facilitated the development of specific concepts or skills identified in the lesson objectives.	0	0	0	6.7	40	53.3	5.47	.64
2. Main concepts were presented logically.	0	0	0	0	60.0	40.0	5.40	.51
3. The information was presented at an age-appropriate pace.	0	0	0	6.7	46.7	46.7	5.40	.63

Table 28. Lesson 2 Instructional Design of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The amount of prerequisite knowledge required to understand the material was acceptable.	0	0	0	14.3	57.1	28.6	5.14	.66
2. The learning objectives were stated clearly.	0	0	0	0	53.3	46.7	5.47	.52
3. The instruction followed an inquiry-based approach.	0	0	0	6.7	40	53.3	5.47	.64

Table 29. Lesson 2 Relevance of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Materials and concepts were related to real life examples.	0	0	6.7	0	80.0	33.3	5.00	.66
2. Module materials and concepts fit nicely with my existing instructional materials.	0	0	7.1	0	57.1	35.7	5.21	.80

Table 30. Lesson 2 Effectiveness in Achieving Learning Outcomes Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Students should be able to define resolution.	0	0	0	33.3	46.7	20.0	4.87	.74
2. Students should be able to explain the relationship between probe size and resolution.	0	0	0	20.0	53.3	26.7	5.07	.70
3. Students should be able to recognize that information in three dimensions is necessary to describe an object fully.	0	0	0	20.0	40.0	40.0	5.20	.78

Table 31. Lesson 2 Website Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The relationship of the website to the lesson was clear.	0	0	0	16.7	41.7	41.7	5.25	.75
2. The students were able to navigate easily in the website without confusion.	9.1	0	0	18.2	27.3	45.5	4.91	1.51
3. The website added to the lesson.	0	0	0	25.0	41.7	33.3	5.08	.79
4. The website material was engaging (i.e. it got us to do interesting things).	0	0	0	16.7	33.3	50.0	5.33	.79

Lesson 2 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. As judged by teachers, the lesson 2 difficulty mean = 4.29, std. dev. = 1.98.

Table 32. Lesson 3 Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The content was accurate and current.	0	0	0	0	28.6	71.4	5.71	.47
2. The reading level was appropriate for my students.	0	0	0	7.7	46.2	46.2	5.38	.65
3. The vocabulary was listed separately in a useful glossary.	11.1	0	0	0	44.4	44.4	5.00	1.58
4. The material stimulated new thinking and inquiry.	0	0	0	14.3	28.6	57.1	5.43	.76
5. The examples and explanations were at the appropriate level.	0	0	0	14.3	50.0	35.7	5.21	.69
6. The material was engaging (i.e. the students got more interested in the science content).	0	0	0	7.1	50.0	42.9	5.36	.63
7. The students could understand the scientific information clearly.	0	0	0	42.9	21.4	35.7	4.93	.92

Table 33. Lesson 3 Graphic Content of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Illustrations, charts, maps, or graphs were clear and meaningful.	0	0	7.1	21.4	28.6	42.9	5.07	.99
2. Graphic content helped students understand the material covered.	0	7.1	0	21.4	35.7	35.7	4.93	1.14
3. Illustrations promoted student thinking, discussion, problem solving, and inquiry.	0	0	0	14.3	28.6	57.1	5.43	.76
4. Illustrations motivated students to read the text.	0	7.1	7.1	28.6	21.4	35.7	4.71	1.27
5. The material was engaging (i.e. it got them to do interesting things	0	7.1	0	0	35.7	57.1	5.36	1.08

Table 34. Lesson 3 Format of the Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Lessons contained an appropriate amount of material.	0	7.1	0	7.1	42.9	42.9	5.14	1.09
2. The size and format of print was appropriate.	0	0	7.1	21.4	28.6	42.9	5.07	.99

Table 35. Lesson 3 Organization of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The organization of the lessons (chronological, thematic) facilitated the development of specific concepts or skills identified in the lesson objectives.	0	0	7.7	0	38.5	53.8	5.38	.87
2. Main concepts were presented logically.	0	0	7.7	7.7	46.2	38.5	5.15	.89
3. The information was presented at an age-appropriate pace.	0	0	0	15.4	38.5	46.2	5.31	.75

Table 36. Lesson 3 Instructional Design of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The amount of prerequisite knowledge required to understand the material was acceptable.	0	0	0	18.2	45.5	36.4	5.18	.75
2. The learning objectives were stated clearly.	0	0	0	23.1	23.1	53.8	5.31	.86
3. The instruction followed an inquiry-based approach.	0	0	0	0	30.8	69.2	5.69	.48

Table 37. Lesson 3 Relevance of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Materials and concepts were related to real life examples.	0	0	0	7.7	23.1	69.2	5.62	.65
2. Module materials and concepts fit nicely with my existing instructional materials.	0	0	8.3	0	25.0	66.7	5.50	.91

Table 38. Lesson 3 Effectiveness in Achieving Learning Outcomes Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Students should be able to explain the use of technologies base on their resolving power.	0	0	6.7	0	42.9	50.0	5.36	.84
2. Students should be able to explain how technologies are used to solve scientific and health-related problems.	0	0	0	0	50.0	50.0	5.50	.52
3. Students should understand the concept of using the right tool for the job.	0	0	0	14.3	28.6	57.1	5.43	.76
4. Students should be able to develop a multi-step research plan in which hypotheses are formulated, data is gathered and interpreted, and new questions are asked.	0	7.1	7.1	21.4	42.9	21.4	4.64	1.15
5. Students should understand the nature of science and how science is done.	0	0	0	14.3	50.0	35.7	5.21	.70

Table 39. Lesson 3 Website Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The relationship of the website to the lesson was clear.	0	0	0	0	23.1	76.9	5.77	.44
2. The students were able to navigate easily in the website without confusion.	0	9.1	9.1	0	45.5	36.4	4.91	1.30
3. The website added to the lesson.	0	0	8.3	25.0	8.3	58.3	5.17	1.15
4. The website material was engaging (i.e. it got us to do interesting things).	0	0	0	8.3	16.7	75.0	5.67	.65

Lesson 3 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. As judged by teachers, the lesson 3 difficulty mean = 4.77, std. dev. = 2.24.

Table 40. Lesson 4 Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The content was accurate and current.	0	0	0	13.3	33.3	53.3	5.40	.74
2. The reading level was appropriate for my students.	0	0	0	8.3	41.7	50.0	5.42	.67
3. The vocabulary was listed separately in a useful glossary.	0	0	0	14.3	14.3	71.4	5.57	.79
4. The material stimulated new thinking and inquiry.	0	0	13.3	13.3	13.3	40.0	5.00	1.07
5. The examples and explanations were at the appropriate level.	0	0	6.7	6.7	40.0	46.7	5.27	.88
6. The material was engaging (i.e. the students got more interested in the science content).	0	0	26.7	6.7	33.3	33.3	4.73	1.22
7. The students could understand the scientific information clearly.	0	0	0	13.3	40.0	46.7	5.33	.72

Table 41. Lesson 4 Graphic Content of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Illustrations, charts, maps, or graphs were clear and meaningful.	0	7.7	0	15.4	30.8	46.2	5.08	1.19
2. Graphic content helped students understand the material covered.	0	0	8.30	16.7	16.7	58.3	5.25	1.05
3. Illustrations promoted student thinking, discussion, problem solving, and inquiry.	0	15.4	0	15.4	38.5	30.8	4.69	1.38
4. Illustrations motivated students to read the text.	0	9.1	9.1	0	45.5	36.4	4.91	1.30
5. The material was engaging (i.e. it got them to do interesting things	0	7.7	7.7	7.7	38.5	38.5	4.92	1.26

Table 42. Lesson 4 Format of the Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Lessons contained an appropriate amount of material.	0	14.3	7.1	0	42.9	35.7	4.79	1.42
2. The size and format of print was appropriate.	6.7	0	13.3	0	53.3	26.7	4.73	1.39

Table 43. Lesson 4 Organization of Text-based Materials Questions Results for Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The organization of the lessons (chronological, thematic) facilitated the development of specific concepts or skills identified in the lesson objectives.	0	0	0	6.7	40.0	53.3	5.47	.64
2. Main concepts were presented logically.	0	0	6.7	0	46.7	46.7	5.33	.82
3. The information was presented at an age-appropriate pace.	0	0	6.7	6.7	46.7	40.0	5.20	.86

Table 44. Lesson 4 Instructional Design of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. The amount of prerequisite knowledge required to understand the material was acceptable.	0	0	7.1	0	50.0	42.9	5.29	.83
2. The learning objectives were stated clearly.	0	6.7	0	6.7	40.0	46.7	5.20	1.08
3. The instruction followed an inquiry-based approach.	0	0	6.7	6.7	46.7	40.0	5.20	.86

Table 45. Lesson 4 Relevance of Text-based Materials Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Materials and concepts were related to real life examples.	0	0	0	14.3	50.0	35.7	5.21	.70
2. Module materials and concepts fit nicely with my existing instructional materials.	0	0	7.7	0	69.2	23.1	5.08	.76

Table 46. Lesson 4 Effectiveness in Achieving Learning Outcomes Questions Results from Teachers.

Question	Percent Strongly Disagree	Percent Disagree	Percent Disagree a Little	Percent Agree a Little	Percent Agree	Percent Strongly Agree	Mean	Std. Dev.
1. Students should be able to describe the need for new or improved technologies.	0	0	7.7	7.7	30.8	53.8	5.31	.95
2. Students should understand the general process of developing technologies, including the need to have input from multiple disciplines.	0	7.1	7.1	7.1	28.6	50.0	5.07	1.27

Lesson 4 Difficulty. The scale used for the difficulty of each lesson was line across the page with three easily identifiable equidistant points for the students to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. As judged by teachers, the lesson 4 difficulty mean = 3.93, std. dev. = 1.82.

Lesson Comparisons. The lessons each have scores from the teachers on several dimensions. Table 47 depicts the average scores for each lesson when compared to the other lessons.

Table 47. Comparison of Lessons by Evaluation Dimension: Teacher Results

Evaluation Dimension	Lesson 1 What is technology? Mean (in bold) & Std. dev.	Lesson 2 Resolving Issues Mean & Std. dev.	Lesson 3 Putting Technology to Work Mean & Std. dev.	Lesson 4 Technology: How Much is Enough? Mean & Std. dev.
Text-based Content	**5.26** .21	**5.26** .48	**5.36** .56	**5.57** .79
Graphic Content	**4.40** .82	**5.43** .43	**5.10** .89	**5.26** .66
Format	**5.18** .82	**5.18** .82	**5.11** .94	**4.82** 1.19
Organization	**5.33** .52	**5.42** .51	**5.28** .71	**5.33** .75
Instructional Design	**5.14** .56	**5.33** .41	**5.39** .61	**5.24** .77
Relevance	**5.29** .51	**5.07** .67	**5.58** .76	**5.12** .55
Achieving Learning Outcomes	**5.38** .47	**5.04** .63	**5.22** .65	**5.31** .95
Website	N/A	**5.18** .73	**5.41** .69	N/A
Level of Difficulty (Scale = 1 - 9)	**4.27** 1.87	**4.29** 1.98	**4.77** 2.24	**3.93** 1.82

In discussions of the utility of replacement or supplementary modules, the notion of difficulty of the modules and individual lessons comes up frequently. Table 48 is a comparison of the levels of difficulty for each lesson as well as the overall module. The scale used for all these estimations by the students and teachers was line across the page with three easily identifiable equidistant points to mark a judgment. At the left extreme was 1 = Extremely Easy, in the middle 5 = Just Right, and at the right extreme 9 = Extremely Hard. The averages are all in the middle range, close to "Just Right", therefore we must conclude that for this module the developers hit their target. The estimated difficulty was slightly higher in student estimations compared to teacher estimates in most cases.

Table 48: Comparison of Means of Teachers and Students Levels of Difficulty (Scale = 1 -9)

	Teachers	Students
Lesson 1: What is Technology?	4.27	4.47
Lesson 2: Resolving Issues	4.29	4.14
Lesson 3: Putting Technology to Work	4.77	5.05
Lesson 4: Technology: How much is enough?	3.93	4.34
Overall Module	4.73	4.89

Module Difficulty. The teachers were also asked about the overall difficulty of the entire module. They rated the difficulty on a scale of 1 to 9 in which 1=too easy, 5=just right, and 9=too hard. The average level of difficulty was 4.73, std. dev. = 1.44.

Most and Least Valuable Aspects of the Module and Suggestions for Improvements. The teachers were asked to respond to an open-ended question on the most valuable aspects of the module and to discuss why. These comments are included in their totality in Appendix J.

Snapshots of Lessons. It is useful for the developers who work on specific lessons to have a picture of the impressions of the teachers and students who used their materials. Tables 49-53 contain information extracted from other tables and put here to provide a "snapshot" of each lesson. In addition, the rankings of these ratings are provided to give an idea of how they compare to other lessons. The rankings are meant to be only useful for gross comparisons. Sometimes the differences between ranks is great, sometimes the difference is quite small.

Table 49. A Formative Evaluation Snapshot of Lesson 1: What is Technology?

	Teacher Rating	Teacher Rank (out of 4 lessons)	Student Rating	Student Rank (out of 4 lessons)
Difficulty	4.27 (Scale = 1 - 9)	3	4.47 (1 - 9)	2
Achieving Learning Outcomes	5.38 (Scale = 1 - 6)	1	N/A	N/A
Text-based Content	5.26 (Scale = 1 - 6)	3	4.58 (Scale = 1 - 6)	2
Graphic Content	5.44 (Scale = 1 - 6)	2	4.29 (Scale = 1 - 6)	3
Format	5.18 (Scale = 1 - 6)	1	N/A	N/A
Organization	5.33 (Scale = 1 - 6)	2	N/A	N/A
Instructional Design	5.14 (Scale = 1 - 6)	4	N/A	N/A
Relevance	5.29 (Scale = 1 - 6)	2	N/A	N/A
Website	N/A	N/A	N/A	N/A

	Teachers	Students
Typical Lesson 1 Comments	Visual idea of cell was good Trouble with math on Activity 2 Questions were repetitive Excellent introduction	No website! Fun Computer lesson was hard to Understand Don't like to read It wasn't easy
Assessment	Lesson 1 rated 2 and 3 out of 4 on difficulty. Teachers rated it highest in achieving learning outcomes. It was 1st or 2nd in graphic content, format, organization, and relevance. After experiencing web activities on other lessons the students seemed to want a web activity on every lesson. Consider problems with Activity 2 and repetitious questions.	

Table 50. A Formative Evaluation Snapshot of Lesson 2: Resolving Issues

	Teacher Rating	Teacher Rank (out of 4 lessons)	Student Rating	Student Rank (out of 4 lessons)
Difficulty	4.29 (Scale = 1 - 9)	2	4.14 (1 - 9)	4
Achieving Learning Outcomes	5.04 (Scale = 1 - 6)	4	N/A	N/A
Text-based Content	5.26 (Scale = 1 - 6)	4	4.54 (Scale = 1 - 6)	3
Graphic Content	5.43 (Scale = 1 - 6)	1	4.41 (Scale = 1 - 6)	1
Format	5.18 (Scale = 1 - 6)	1	N/A	N/A
Organization	5.42 (Scale = 1 - 6)	1	N/A	N/A
Instructional Design	5.33 (Scale = 1 - 6)	4	N/A	N/A
Relevance	5.07 (Scale = 1 - 6)	2	N/A	N/A
Website	5.18 (Scale = 1 - 6)	2 (2 lessons had web activities)	4.71 (Scale = 1 - 6)	2 (2 lessons had web activities)
		Teachers		**Students**
Typical Lesson 2 Comments		Students loved the activity. Difficulty following instructions for the probe. Difficulty with resolution. Website not working. Need better direction for building robot.		It was fun. Liked the battleship game. Website wasn't working. The bread activity made me think. Use doughnuts instead of bread...more fun.
Assessment		Lesson 2 rated 2 and 4 out of 4 on difficulty. Teachers rated it lowest in achieving learning outcomes. It was, however, rated highest in graphic content, format, and organization. The web site in Lesson 3 was more highly ranked than the Lesson 2 web site. Students liked the battleship game and bread activity but there were difficulties with understanding resolution. Consider rewriting directions for the robot activity and switching to Krispy Kreme donuts!		

Table 51. A Formative Evaluation Snapshot of Lesson 3: Putting Technology to Work

	Teacher Rating	Teacher Rank (out of 4 lessons)	Student Rating	Student Rank (out of 4 lessons)
Difficulty	4.77 (Scale = 1 - 9)	1	5.05 (1 - 9)	1
Achieving Learning Outcomes	5.22 (Scale = 1 - 6)	3	N/A	N/A
Text-based Content	5.36 (Scale = 1 - 6)	2	4.45 (Scale = 1 - 6)	4
Graphic Content	5.10 (Scale = 1 - 6)	3	4.40 (Scale = 1 - 6)	2
Format	5.11 (Scale = 1 - 6)	4	N/A	N/A
Organization	5.28 (Scale = 1 - 6)	4	N/A	N/A
Instructional Design	5.39 (Scale = 1 - 6)	1	N/A	N/A
Relevance	5.58 (Scale = 1 - 6)	1	N/A	N/A
Website	5.41 (Scale = 1 - 6)	1 (2 lessons had web activities)	5.05 (Scale = 1 - 6)	1 (2 lessons had web activities)
		Teachers		**Students**
Typical Lesson 3 Comments		A few students struggled because no vocabulary listed. 3.4 was very confusing. Students had a hard time with so much information. Start with Bread lesson...no prior knowledge needed.		The lesson was fun. Good website. Very good lesson. Website not working. Confusing...couldn't tell what I was supposed to do next. Graphics were very useful.
Assessment		Lesson 3 rated highest on difficulty with both teachers and students. Teachers rated it high on text content, relevance, and instructional design. The web activity was highly rated and an outstanding feature of this lesson. Consider the issue of too much information, section 3.4, and putting key terms in a glossary. Just because it is difficult does not mean you have to water it down. You might consider brainstorming on ways to reduce difficulty.		

Table 52. A Formative Evaluation Snapshot of Lesson 4: Technology: How Much is Enough?

	Teacher Rating	Teacher Rank (out of 4 lessons)	Student Rating	Student Rank (out of 4 lessons)
Difficulty	3.93 (Scale = 1 - 9)	4	4.34 (1 - 9)	3
Achieving Learning Outcomes	5.31 (Scale = 1 - 6)	2	N/A	N/A
Text-based Content	5.57 (Scale = 1 - 6)	1	4.69 (Scale = 1 - 6)	1
Graphic Content	5.26 (Scale = 1 - 6)	2	4.23 (Scale = 1 - 6)	4
Format	4.82 (Scale = 1 - 6)	4	N/A	N/A
Organization	5.33 (Scale = 1 - 6)	2	N/A	N/A
Instructional Design	5.24 (Scale = 1 - 6)	3	N/A	N/A
Relevance	5.12 (Scale = 1 - 6)	3	N/A	N/A
Website	N/A	N/A	N/A	N/A

		Teachers	Students	
Typical Lesson 4 Comments		My students did not like this. Students were immediately engaged. Excellent graphics. Text/images too small for Overheads. Students were "letdown" because not web activity.	No website. Boring. Rewrite or remove History. Time allowed to short. Not enough time to write essays. Needs improvement.	
Assessment	Lesson 4 rated 4 and 3 out of 4 on difficulty. Teachers rated it high on text content, graphic content, and organization but lowest in format. After experiencing web activities on other lessons the students seemed to want a web activity on every lesson. Consider advising teachers to give more time for some activities and enhancing the History section to create more interest.			

Additional Analyses

Teacher Background Materials Evaluation. The teachers were asked to respond to a second set of questions about the background materials in a follow up survey after they had returned their evaluation materials. The survey was constructed with Perseus Software and sent to them at their

email addresses. This software allows them to merely click on a URL in the email message which brings up the survey on their system. They then click on their responses or type in answers to open-ended questions, then click on a "Submit Survey" button. They respondents are then automatically returned to their email software program. The survey responses come back to us automatically and are installed in an Access database which we can analyze with SPSS. The responses are anonymous unless you ask the respondent to identify themselves which of course we had to do to match the responses with the rest of their data in our database. We did this for two reasons: (1) an oversight by the project evaluator in neglecting to put those questions on the mailed out questionnaire, and (2) to serve as a test for future applications of this technology for other BSCS projects. A copy of the Perseus web-based survey is included in Appendix H. Table 53 contains the results of the first three questions. Tables 54-57 contain the results of the open-ended questions. All the tables must be viewed with caution because there are fewer responses than to the general TEMS questionnaire.

Table 53. Teacher Background Materials Evaluation.

Question	Strongly Disagree	Disagree	Disagree a Little	Agree a Little	Agree	Strongly Agree	Mean	Std. Dev.
1. Overall, the Teacher Background Materials for this teaching unit were very useful.	0	0	0	0	50%	50%	5.5 (n=4)	.58
2. I found the references quite useful.	0	0	0	25%	75%	0	4.75 (n=4)	.50
3. I would prefer to have the references inserted in the text of the Teacher Background section.	0	25%	0	25%	25%	25%	4.25 (n=4)	1.71

Table 54. The three most important features of the Teacher Background materials for me were:

RESPONSES
Organization of the materials was very good.
Information provided good background and orientation for module.
Whenever students had questions about technologies, I felt well-prepared.
Readability: I thought reading passages were at the appropriate level for a science teacher.
The conceptual flow of the lessons.
Section 4.0
Implementing the Module, pg xv
Major misconceptions were very helpful in anticipating what students would and would not know.
Very comprehensive and basically easy to read and understand.
There is a lot of info in a small space and it really provided me with additional knowledge that I did not know.

Table 55. I would like to have seen the following additional information in the Teacher Background materials.

RESPONSES
Need discussion of difference in size between viruses and bacteria.
Additional websites to access related materials. I don't have time to browse through entire books or magazines.
I wouldn't mind some larger pictures for overheads.

Table 56. The Teacher Background materials could have omitted the following:

RESPONSES
I would like to see section 4.0 less "bookish" and more dictionary-like.
The teacher background materials were very effective and useful in the original method that they were presented.

Table 57. How could the Teacher Background materials be made more useful?

RESPONSES
Don't want to step on NIH toes but I didn't need quite so much NIH background.

D.   Results of Summative Evaluation

The summative evaluation consists primarily of examination of the differences between the student's Pretest and Posttest scores on a "Student Knowledge Survey". The items were statements which the students could indicate True, False, or Not Sure. Appendices E and F contain copies of these surveys. The students took the first Knowledge survey (the Pretest) before exposure to the materials and the Posttest after using the materials. All students answered questions 1 – 15. Additionally, analysis of the "Not Sure" responses was conducted as well as the teacher's estimates of the success in achieving learning outcomes.

T-Tests. The students' answers were scored with answer keys which yielded the number of items they got correct. The Not Sure responses were scored as incorrect in the initial analyses. The mean number of correct responses on the Pretest = 6.51 (out of 15, Std. Dev. = 2.50). The mean number of correct responses on the Posttest = 9.57 (out of 15, Std. Dev. = 2.83). The t-test for Pretest and Posttest scores (using questions 1-15) was -27.77, df=517, p <.01.

One-way Analysis of Variance. A one-way analysis of variance was also conducted because t-tests are primarily comparisons of significant differences between means. The one-way analysis of variance gives us an idea of whether the variances in the scores also are significantly different. The obtained F value = 17.76, p<.01. This means that the variances were significantly different. Based on the t-tests and the one-way ANOVA we have substantial evidence that the materials increased student learning of the items covered in the Knowledge Test

Correlation. It is also useful in conceptualizing the relationship between pretest and posttest scores to view them as correlates. Essentially, this view is that the higher a score on the pretest, the higher the score on the posttest, or what is termed a "positive correlation". Since the variables are interval level measures a Pearson's r correlation coefficient was calculated. The Pearson's r for the pretest and posttest scores = .565, p<.01. This is a statistically significant correlation. Essentially, this means that when you take the square of the .565 figure to obtain r^2 you get the amount of variance in the posttest scores which is explained by the pretest scores. This r^2 = .32 or 32 percent of the variance in the posttest scores is explained by the preexisting level of knowledge which was measured by the pretest scores. It can be assumed that the remaining variance in the posttest scores (that is, most of it) is explained by other factors, such as exposure to the instructional materials and teaching the students have received.

Analysis of "Not Sure" Responses. In addition to the analysis of the True-False answers on the Pretest and Posttest Knowledge Surveys, there is a "Not Sure" category of response. This response was offered on the survey because it essentially is a non-threatening option for students to choose when they in fact don't know what is the answer. The is entirely possible for many students because they had not yet covered the material. Correct answers are probably the result of their own reading, good guessing, or luck. We wanted to establish that it was OK to say they did not know the material rather than to guess. Therefore, scores were computed for the number of "Not Sure" responses for each student on the Pretest and the Post Test. The mean number of Not Sure responses for the Pretest = 4.63 (out of 15, Std. Dev. = 3.02). The mean number of Not Sure responses for the Posttest = 1.92 (out of 15, Std. Dev. = 2.36). The t-test for these means = 23.32, df = 517, p<.01). This means that the average number of Not Sure responses was substantially lower in the Posttest than in the Pretest. Guessing or uncertainty seems to have been diminished.

Teacher Estimation of Achieving Learning Outcomes. The pretest and posttest scores are the primary method of determining the results of the summative evaluation. Another input for this evaluation is the judgments of the teachers on how effective the lessons and the overall module were in achieving the learning outcomes. Tables 17-46 give the distribution of responses from the teachers. Table 58 below summarizes the results of those tables. The scale is 1= Strongly Disagree, 2=Disagree, 3=Disagree a Little, 4=Agree a Little, 5=Agree, 6=Strongly Agree.
      The questions the teachers were answering were whether they agreed or disagreed that the lessons were effective in achieving the specific lesson learning outcomes. The table clearly shows that the teacher judgments fell predominantly in the Agree and Strongly Agree range on these statements. The lowest score were in Lesson 3: Outcome 4 and Lesson 2: Outcome 1. These scores, however, were still in the Agree range. The highest scores were on Lesson 1: Outcome 1 and Lesson 3: Outcomes 2 and 3.

Table 58. Teachers Summative Judgments on Achieving Learning Outcomes.

Learning Outcomes	Mean & (Std. dev.) (Scale = 1-6)
Lesson 1 Learning Outcomes	
1. Students should be able to explain what technology is.	5.47 (.49)
2. Students should recognize that human intervention is the common bond among technologies.	5.33 (.62)
3. Students should be able to use the scale to distinguish between "large" and "small" objects..	5.29 (.73)
Lesson 2 Learning Outcomes	
1. Students should be able to define resolution.	4.87 (.75)
2. Students should be able to explain the relationship between probe size and resolution.	5.07 (.70)
3. Students should be able to recognize that information in three dimensions is necessary to describe an object fully.	5.20 (.78)
Lesson 3 Learning Outcomes	
1. Students should be able to explain the use of technologies base on their resolving power.	5.36 (.84)
2. Students should be able to explain how technologies are used to solve scientific and health-related problems.	5.50 (.52)
3. Students should understand the concept of using the right tool for the job.	5.43 (.76)
4. Students should be able to develop a multi-step research plan in which hypotheses are formulated, data is gathered and interpreted, and new questions are asked.	4.64 (1.15)
5. Students should understand the nature of science and how science is done.	5.21 (.70)
Lesson 4 Learning Outcomes	
1. Students should be able to describe the need for new or improved technologies.	5.31 (.95)
2. Students should understand the general process of developing technologies, including the need to have input from multiple disciplines.	5.07 (1.27)

Additional Analyses.

School Comparisons. In analyzing the data it is also useful to break down differences between sampled units. Schools were selected to be in the field test because they differed in terms of geographic region and racial and ethnic composition of the student body. The primary sites received a field test orientation and the secondary sites did not. The t-tests reported are paired comparisons. The difference (or gain) scores are calculated by subtracting the pretest mean from the posttest mean. Table 59 contains the result of these analyses.

Table 59. School Comparisons on Pretest and Posttest results.

School	Primary or Secondary Site	n	SKS1 (Pretest)	SKS2 (Posttest)	t-test	Difference (Gain) Score
1. Carrington HS	Primary	42	Mean = **6.73**	Mean = **9.90**	t = 7.56 p<.01	3.17
2. Pine Creek HS	Primary	40	Mean = **8.76**	Mean = **12.73**	t = 9.49 p<.01	3.97
3. Lafayette HS	Primary	24	Mean = **5.92**	Mean = **8.92**	t = 5.83 p<.01	3.00
4. Jay Sci Acad.	Primary	30	Mean = **6.37**	Mean = **8.5**	t = 5.18 p<.01	2.13
5. King Kakaulike HS	Primary	50	Mean = **6.42**	Mean = **10.1**	t = 10.46 p<.01	3.68
6. Monte Vista HS	Primary	36	Mean = **7.33**	Mean = **11.44**	t = 15.42 p<.01	4.11
7. Eastern HS	Primary	28	Mean = **5.14**	Mean = **7.07**	t = 3.77 p<.01	1.93
8. Northwest HS	Primary	56	Mean = **5.14**	Mean = **7.14**	t = 5.40 p<.01	2.00
9. Cornell HS	Secondary	35	Mean = **5.77**	Mean = **8.94**	t = 6.88 p<.01	3.17
10. Mt. Michael HS	Secondary	36	Mean = **7.25**	Mean = **10.89**	t = 8.95 p<.01	3.64
11. Sallisaw HS	Secondary	30	Mean = **5.53**	Mean = **7.40**	t = 5.69 p<.01	1.87
12. Catholic Central HS	Secondary	17	Mean = **7.12**	Mean = **10.71**	t = 7.63 p<.01	3.59
13. Joliet Central HS	Secondary	94	Mean = **6.79**	Mean = **9.99**	t = 13.65 p<.01	3.20

The average difference score for the primary schools was 2.99 and for the secondary schools the average difference was 3.09 or almost exactly the same. This would suggest that the materials can stand on their own and that the teachers can use them successfully without having the extra advantage of a field test orientation.

Another way of visualizing the results of comparing the schools is depicted in Table 60. This table shows the results of the pretest for each primary school along with its posttest results.

Table 60. Another Comparison of Pretest and Posttest Scores
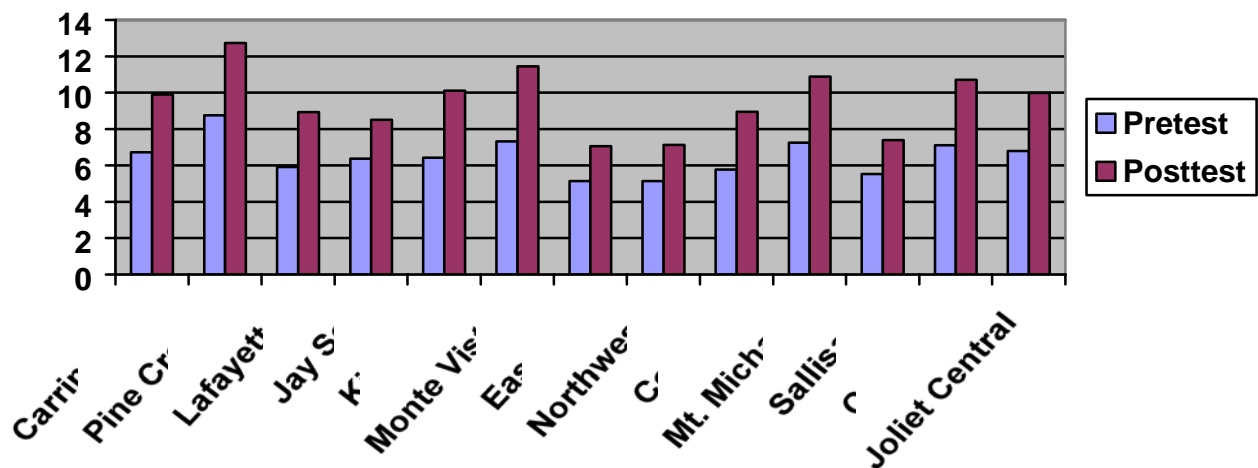
Primary versus Secondary Field Test Teachers Comparisons. There were 8 primary field test teachers who participated in a Field Test Orientation and who were paid to participate in the study. In addition, there were 5 secondary field test teachers who wanted to be in the study but were not selected, principally because we had met the requirement for the study and there were not sufficient funds to pay for their travel, expenses, or field test payment. The significance of these comparisons is found primarily in the fact that the primary field test teachers had the orientation and the secondary field test teachers did not. Tables 61-63 depict the results of this comparison.

Table 61. Primary versus Secondary Field Test Site Pretest and Posttest results.

	SKS 1 (Pretest)	SKS2 (Posttest)	t-test
1. Primary Field Test Sites	Mean = 6.48 Std. dev. = 2.63	Mean = 9.51 Std. dev. = 2.90	t = 20.19 , p<.01
2. Secondary Field Test Sites	Mean = 6.55 Std. dev. = 2.31	Mean = 9.66 Std. dev. = 2.73	t = 19.36, p<.01

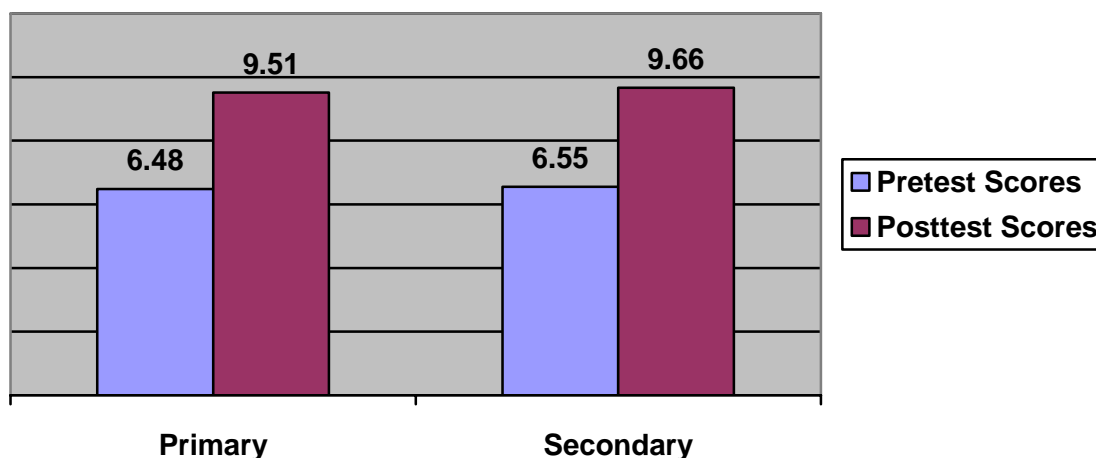**Table 62. Primary (Combined) and Secondary (Combined) Field Test Sites Comparison**

Table 63. Primary versus Secondary Field Test Teachers Comparisons on Selected Variables.

	Primary	Secondary	t-test
Overall Module Difficulty	**Mean = 4.76** Std. dev. = 1.75	**Mean = 5.08** Std. dev. = 1.77	t = 2.072 P>.01(not sig.)
Lesson 1 Difficulty	**Mean = 4.41** Std. dev. = 1.85	**Mean = 4.56** Std. dev. = 1.88	t = .926 p>.01 (not sig.)
Students Level of interest in Biology (Scale = 1-9)	**Mean = 4.03** Std. dev. = 1.24	**Mean = 3.91** Std. dev. = 1.26	t = 1.15 p>.01 (not sig.)

Section V. Discussion of Results

      A.   **Field Test Demographics**.

      There inevitably is a conflict between the need for representative samples and the demands of the real world to identify and access willing teachers and students. In field tests, it is logical to identify teachers who are willing, capable, and have the laboratory resources to conduct the tests even though their classes might not yield representative samples. The goal of the evaluation is to test and evaluate new curriculum materials. What better set of subjects to test than those who can use it and articulate its advantages and disadvantages?

      The primary field test sites were quite diverse. They varied in urban-suburban-rural, racial/ethnic composition, and geographic region of the U.S. The secondary sites were "opportunistic" in nature, that is, they were included because they applied not because they helped

establish "inclusiveness" in any way. They are included in many of the analyses and were compared to the primary groups to examine possible differences.

B. Formative Evaluation Results from Students.

Utility of Student Results for Developers. In general the results in Tables 5 to 16 are most useful to the developers to obtain the impressions of the students on the different areas of evaluation. The percentage results on all lessons are more dispersed and have more disagreement than the teachers' answers for similar questions. It is suggested that the developers review the separate tables for each lesson and focus on those with the most dispersed and lowest average scores to find room for improvement. For example, in Lesson 2, the lowest average response from the students on the questions on Text-based Materials was the statement "The lesson made me think about new things and questions". The average was 4.19 which is in the *agree a little* range. This might be a candidate for improvement. Comparing the same average of responses to questions across the lessons will give you an idea of how well the different lessons were evaluated by the students.

Comments from Students. Appendix I contains the comments from the students on Lessons 1-4, the Most and Least Valuable Aspects of the Module, and Suggestions for Improvements. Because there are responses for 569 students this is a large appendix with many comments. The Most Valuable Aspects of the Module included items such as the Battleship/Probe Game, using websites, being in groups, investigating viruses, and hands-on activities. The Least Valuable Aspects of the Module included items such as the Battleship/Probe Game, the history section, filling out surveys, resolution, the time crunch, and dislike of reading. Suggestions for improvements included items such as more web activities, improving lesson 4, more games, and making it harder or easier. These items are only a sample of the many comments made by students. The developers should review the comments in each section to see the diversity and number of comments and to identify possible areas for change.

Comparison of Student Results on Lessons. Table 16 contains the results of calculating the averages for the various sets of questions on different evaluation dimensions: Text-based Content, Graphic Content, the Website. The Text-based Content and Graphic Content results are very similar for all the lessons.

Lesson and Overall Module Difficulty for Students. The results on the level of difficulty judgments by students suggests that even though they are all close to the *just right* mark that lesson 3 was perceived as the most difficult and lesson 2 as the easiest by the students.

C. Formative Evaluation Results from Teachers.

Utility of Teacher Results for Developers. Even a brief perusal of the results depicted in Tables 17-46 clearly shows that the results from the teachers are less dispersed and focused more in the *agree* range. The average for virtually all the questions was higher than the results for similar questions asked of the students. Again, the task for the developers in examining these tables is to focus on the low scores and most dispersed sets of responses to statements. In so doing, they should identify likely candidates for modifications and improvements in the materials.

Comments from Teachers. Appendix J contains the comments from the teachers on Lessons 1-4, the Most and Least Valuable Aspects of the Module, and Suggestions for Improvements. The Most Valuable Aspects of the Module included items such as the Battleship/Probe Game, using websites, the slicing of bread experiment, technology being well explained, and incorporating inquiry. Least Valuable Aspects of the Module included items such as the Activity 4 needing work, more time allocated to writing up reports, and redundant questions. Suggestions for improvements included items such as improving lesson 4, making instructions more specific and simple, redoing the history section, and adding sound effects. These items are only a sample of the many comments made by teachers. The developers should review the comments in each section to identify candidate areas for changes.

Comparison of Teacher Ratings on Lessons. Table 47 contains the results of calculating the averages for the various sets of questions on the different evaluation dimensions. Most of the results are in the *agree* range on these items. However, the developer can identify strong and weak areas of lessons by comparing the lessons to each other, much as the teachers and students did. In this manner, the graphic content of lesson was evaluated lowest, the format of lesson 4 was evaluated lowest, and so forth. Interestingly, as opposed to the students, the teachers thought that lesson 4 was the least difficult and lesson 3 was the most difficult. It should be noted however, that all the difficulty score averages from the teachers were below, that is *easier*, than the "just right" score of 5.

Lesson and Overall Module Difficulty. Table 48 is a comparison of the results of the lessons' and overall module difficulty scores of the teachers and students. As might be expected, the students evaluated the overall module and most of the lessons as more difficult.

Teacher Background Materials. The questions asking for evaluation information on the Teacher Background Materials yielded positive results. The results in Table 53 suggest that the materials were useful and the references useful. Most teachers agreed that the references should be in the text of the Background materials. Comments on the best features included organization, readability, conceptual flow, and the way major misconceptions on the subject matter were handled. The teachers wanted more websites and larger pictures to be able to print off larger copies for overhead projection.

D. Summative Evaluation Results.

Student Knowledge Surveys. The results from the student knowledge surveys clearly showed that the module had the intended instructional impact. The results are conclusive on all lessons.

Teacher Judgment on Effectiveness in Achieving Learning Outcomes. We also obtained the additional input of summative data from the teachers on achieving the learning outcomes for the various lessons. These results, in Table 58, clearly support the student knowledge survey results. The module was a summative success.

Primary and Secondary Field Test Sites Comparison. Tables 59-63 show comparisons between the primary and secondary field test sites on selected variables and the pretest and posttest scores. The results indicate that there are no significant differences between the two groups.

Section VI.   Conclusions and Recommendations

A.   Conclusions

The formative evaluation of the Technology Module Materials clearly shows that the module has been very well crafted and most of the modifications will be of a fine-tuning nature not an overhaul. The open-ended responses yielded a mixed set of comments about what the students and teachers liked and disliked. The responses should be examined by the developers and overlaid with the results of the site visits by staff to obtain most likely areas for improvement to the module.

The summative evaluation results suggest that the module was very effective in all lessons and yielded statistically significant changes in scores from pretest to posttest results as well as high judgments by teachers of the effectiveness in achieving learning outcomes.

B.   Recommendations Regarding the Project

Primary versus Secondary Teachers and Sites.   It would be useful in future applications to have more secondary sites to compare results. If the project director were to pay the secondary teachers a nominal fee of perhaps $100.00 to return the evaluation materials it might substantially increase the return rate for these materials. This is useful because the comparison between these two types of sites gives us insight into whether the professional development offered in the field test orientation to the primary teachers really is necessary to effectively use the materials.

Time for Evaluation Data Entry and Analysis. The Technology module was used in February - March of 2002 with the evaluation materials returned to BSCS in March.   After receipt of the questionnaires the data entry was begun. The evaluation reports for this module as well as the Brain and Energy Balance modules all have due dates of 1 May 2002. It is recommended that on future proposals more time be allocated to the evaluation data entry and analysis for review, contemplation of results, and report writing.

Pilot Test Formative Evaluation. It is recommended that a local pilot test be included in future proposals and that early formative data gathered be included in modifications to the module materials.

Access by Persons with Disabilities (PWDs). It is recommended that we create curriculum materials, in all their various forms, in ways that allows access by persons with disabilities (PWDs). One of the populations of American society which will benefit greatly from technological advances in computers, CD-ROMs, DVDs, websites and internet access in general are persons with disabilities. The Americans with Disabilities Act (ADA) was passed in 1993 and sets standards and mechanisms for access for PWDs. The Department of Education has a number of agencies working to improve access by PWDs such as the National Institute on Disability and Rehabilitation Research (NIDRR). Also, Congress passed the Workforce Investment Act in 1998 which mandates changes in software and peripheral devices to allow access by PWDs.

We should consider enabling access to our curriculum materials by PWDs and including the cost and time of doing so in our proposals. The modifications are somewhat different for different types of disabilities and often depend on unique technology which the PWD has at their location

(such as software on their computer which enlarges text for visually impaired persons). The software for websites can be written in such a fashion as to enable the use of the different input and output devices used by PWDs.   Usually, websites are not so constructed. The nonprofit Center for Applied Special Technology (CAST) has procedures to follow to do this and subsequently receive their "Bobby-Approved" status. This approval indicates to the disabled community that certain standards have been met and they will likely have no trouble accessing the site <www.cast.org>. These types of innovations in our curriculum materials, whether stand alone, such as a CD-ROM, or installed and accessible at our website, would make the materials available to a much wider audience.

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